PARTIAL STRUCTURAL TRANSFORMATION OF NiMn IN EXCHANGE BIASED $Fe_{20}Ni_{80}/Ni_{30}Mn_{70}/Fe_{20}Ni_{80}$ THIN FILMS

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Features of crystal structure and exchange bias of annealed $Fe_{20}Ni_{80}/Ni_{30}Mn_{70}/Fe_{20}Ni_{80}$ thin films are investigated. Temperature dependences of hysteresis loops reveal that for a sample with a thicker FeNi bottom layer a blocking temperature exceeds a Néel temperature of *A*1 γ-NiMn by 20K, while for a sample with a thinner FeNi bottom layer a blocking temperature is larger than the Néel temperature by 140K. An explanation of the influence of the bottom FeNi layer on the phase transformation in NiMn is proposed.

When a ferromagnetic layer of a film is in proximity to an antiferromagnetic one an interesting phenomenon may be observed. The phenomenon is called exchange bias and it manifests itself in a hysteresis loop displacement along the field axis – exchange bias field H_{ex} – at temperatures lower than a blocking temperature T_B, normally accompanied by a coercivity H_c enhancement [1]. Systems with exchange bias are extensively employed in magnetic sensors and memory devices. These applications require temperature stability of exchange bias and consequently a high T_B. NiMn is an antiferromagnet that is able to meet these requirements, but only in its ordered $L1_0$ θ-phase with a Néel temperature T_N – a critical temperature below which the antiferromagnetic ordering is present – greater than 1000K [2]. However, magnetron-sputtered films, such as the ones investigated in the present work, tend to form the disordered *A*1 γ-NiMn with $T_N \approx 400$K [2]. A transformation of γ-NiMn into θ-NiMn occurs under annealing [2].

In this work we study films with the following structures: glass/Ta(5nm)/$Fe_{20}Ni_{80}$(5nm/40nm)/$Ni_{30}Mn_{70}$(20nm)/$Fe_{20}Ni_{80}$(40nm/5nm)/Ta(5nm). Samples were annealed immediately after deposition in the vacuum chamber of an ORION-8 magnetron-sputtering device at 250°C for 1h. Temperature dependences of H_{ex} were measured with a help of a LakeShore vibrating sample magnetometer (VSM) and are present in Fig.1. We also studied domain structure of the samples via an evico magnetics magnetooptical Kerr-magnetometer and their crystal structure by X-ray diffractometry (XRD).

It turns out that the presence of a 40nm-thick FeNi layer underneath NiMn impedes the γ-to-θ transformation, as in this case T_B is slightly higher than T_N of γ-NiMn and is 420K. In the case of a 5nm-thick FeNi evidently more NiMn grains transformed into θ-NiMn, as T_B = 540K which is about 140K higher than T_N of γ-NiMn. Using magnetic properties data and XRD patterns we propose an explanation of the experimental results.

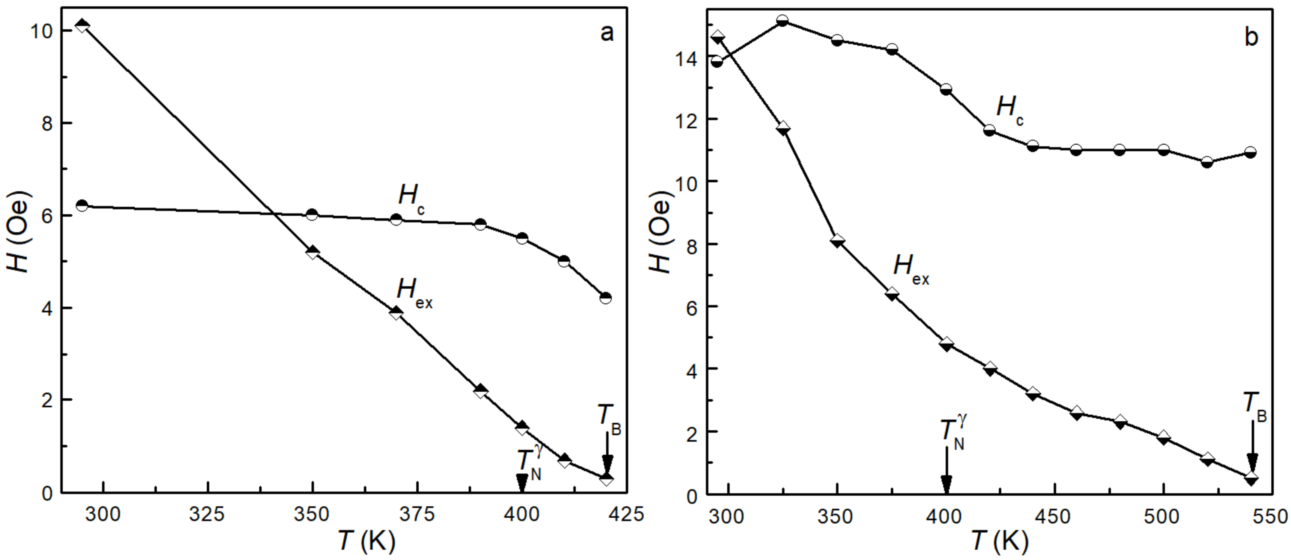

Fig. 1. Exchange bias field H_{ex} and coercivity H_c of a 40nm-thick FeNi layer vs temperature T for FeNi(40nm)/NiMn(20nm)/FeNi(40nm) (a) and FeNi(5nm)/NiMn(20nm)/FeNi(40nm) (b) films

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ТРЕХМЕРНЫЕ ЧИРПИРОВАННЫЕ СВЕТОВЫЕ ПУЛИ В УГЛЕРОДНЫХ НАНОТРУБКАХ

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THREE-DIMENSIONAL CHIRPED LIGHT BULLETS IN CARBON NANOTUBES

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Annotation. The problem of the dynamics of three-dimensional chirped pulses (light bullets) in carbon nanotubes is considered. It is shown numerically that the proposed type of beam demonstrates stable propagation.

Чирп оптического импульса обычно понимается как временная зависимость его мгновенной частоты. В частности, восходящий чирп (down-chirp) означает, что мгновенная частота увеличивается со временем.